

SCIENCE

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FRIDAY, AUGUST 16, 1895.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Prof. J. McKeen Cattell, Garrison on Hudson, N. Y.
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THE HODGKINS FUND PRIZES.

REPORT OF THE COMMITTEE APPOINTED BY THE SMITHSONIAN INSTITUTION TO AWARD THE HODGKINS FUND PRIZES.

THE Committee of Award for the Hodgkins prizes of the Smithsonian Institution

has completed its examination of the two hundred and eighteen papers submitted in competition by contestants.

The Committee is composed of the following members:

Dr. S. P. Langley, chairman, *ex-officio*; Dr. G. Brown Goode, appointed by the Secretary of the Smithsonian Institution; Assistant Surgeon-General John S. Billings, by the President of the National Academy of Sciences; Professor M. W. Harrington, by the President of the American Association for the Advancement of Science.

The Foreign Advisory Committee, as first constituted, was represented by Monsieur J. Janssen, Professor T. H. Huxley and Professor von Helmholtz; and after the recent loss of the latter, Dr. W. von Bezold was added. After consultation with these eminent men, the Committee decided as follows:

First prize, of ten thousand dollars, for a treatise embodying some new and important discoveries in regard to the nature or properties of atmospheric air, to Lord Rayleigh, of London, and Professor William Ramsay, of the University College, London, for the discovery of *Argon*, a new element of the atmosphere.

The second prize, of two thousand dollars, is not awarded, owing to the failure of any contestant to comply strictly with the terms of the offer.

The third prize, of one thousand dollars,

to Dr. Henry de Varigny, of Paris, for the best popular treatise upon atmospheric air, its properties and relationships. Dr. de Varigny's essay is entitled 'L'Air et la Vie.'

(Signed) S. P. LANGLEY,
G. BROWN GOODE,
J. S. BILLINGS,
M. W. HARRINGTON.

AUGUST 9, 1895.

SUPPLEMENTARY REPORT OF THE COMMITTEE
APPOINTED BY THE SMITHSONIAN
INSTITUTION TO AWARD THE
HODGKINS FUND PRIZES.

After having performed the function to which the Committee was called, as announced by the circular of the Secretary of the Smithsonian Institution, dated March 31, 1893, which function did not include the award of any medals, there remained several papers to which the Committee had been unable to give any prize but to which they had felt desirous to give some honorable mention, and on their representing this to the Smithsonian Institution they have been commissioned to do so, and also to give certain medals of silver and bronze which had been subsequently placed at their disposition.

The Committee has decided that honorable mention should be made of the papers, twenty-one in number, included in the following list, which also gives the full names, titles and addresses of the authors, and the mottoes or pseudonyms which in four instances were employed. To three of the papers a silver medal is awarded and to six a bronze medal.

HONORABLE MENTION WITH SILVER MEDAL.

Prof. A. L. Herrera and Doctor Vergara Lopez, of the City of Mexico: 'La Atmosfera de las altitudes y el bienestar del hombre.'

Mr. C. L. Madsen, ('Geo,') Helsingør, near Copenhagen, Denmark.

Thermographical Studies: Mr. F. A. R. Russell, of London, Vice President of

the Royal Meteorological Society of Great Britain: 'The Atmosphere in relation to Human Life and Health.'

HONORABLE MENTION WITH BRONZE MEDAL.

M. E. Deburaux-Dex and M. Maurice Dibos, ('Spes,') of Rouen, France: 'Etudes des courants aériens continentaux et de leur utilisation par des aérostats long-courriers.'

Doctor O. Jesse, of Berlin: 'Die leuchtenden Nachtwolken.'

Doctor A. Loewy, of Berlin: 'Untersuchungen ueber die Respiration und Circulation unter verdünnter und verdichteter Sauerstoffärmer und sauerstoffreicher Luft.'

Mr. Alexander McAdie ('Dalgetty'), of Washington: "The known properties of atmospheric air considered in their relationships to research in every department of natural science, and the importance of a study of the atmosphere considered in view of these relationships: the proper direction of future research in connection with the imperfections of our knowledge of atmospheric air and the conditions of that knowledge with other sciences."

Mr. Hiram S. Maxim, of Kent, England: 'Natural and Artificial Flight.'

Doctor Franz Oppenheimer and Doctor Carl Oppenheimer ('E pur si muove'), of Berlin, Germany: 'Ueber atmosphärische Luft, ihre Eigenschaften und ihren Zusammenhang mit dem menschlichen Leben.'

HONORABLE MENTION.

Mr. E. C. C. Baly, of University College, London: 'The decomposition of the two constituents of the atmosphere by means of the passage of the electric spark.'

Professor F. H. Bigelow, of Washington: 'Solar and Terrestrial Magnetism and their relation to Meteorology.'

Doctor J. B. Cohen, of Yorkshire College, Leeds, England: 'The Air of Towns.'

Doctor F. J. B. Cordeiro, U. S. N., of Washington: 'Hypsometry.'

Professor Emile Duclaux, of the French Institute, Paris, France: 'Sur l'actinométrie atmosphérique et sur la constitution actinique de l'atmosphère.'

Professor Doctor Gieseler, of Bonn, Germany: 'Mittlere Tagestemperaturen von Bonn, 1848-88.'

Doctor Ludwig Ilosvay von Nagy Iloosva, Professor in the Royal Joseph Polytechnic School, Budapest, Hungary: 'Ueber den unmittelbar oxydirenden Bestandtheil der Luft.'

Doctor A. Magelssen, of Christiania, Norway: 'Ueber den Zusammenhang und die Verwandtschaft der biologischen, meteorologischen und kosmischen Erscheinungen.'

Doctor A. Marcuse, of the Royal Observatory, Berlin, Germany: 'Die atmosphärische Luft.'

Professor C. Nees, of the Polytechnic School, Copenhagen, Denmark: 'The use of kites and chained air-balloons for observing the velocity of winds, etc.'

Surgeon Charles Smart, U. S. A., of Washington: 'An Essay on the Properties, Constitution and Impurities of Atmospheric Air, in relation to the promotion of Health and Longevity.'

Doctor F. Viault, of the Faculty of Medicine, Bordeaux, France: 'Découverte d'une nouvelle et importante propriété physiologique de l'Air atmosphérique (action hématogène de l'air raréfié).'

(Signed) S. P. LANGLEY,
G. BROWN GOODE,
J. S. BILLINGS,
M. W. HARRINGTON.

AUGUST 9, 1895.

*THE HISTORY, AIMS AND IMPORTANCE OF
THE AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE.*

THE year 1839 was one of great scientific activity in this country, and in the older States regularly organized geological and zoölogical surveys were in progress which

had called into the field nearly all the scientific men in the country in various capacities. Many of our earlier scientists owe their fame to the opportunities then offered for solving the great problems in science which were met at every step. At that time science was still in its infancy, and the officers of the several State Surveys felt the necessity of comparing notes and discussing results. As a consequence it was agreed upon among them to form an Association of Geologists and Naturalists which should meet every year and discuss the facts and theories which every man was working out in his own State.

The first meeting of this Association was in Philadelphia in April, 1840, under the presidency of Edward Hitchcock, the head of the Geological Survey of Massachusetts. The second meeting was also held in Philadelphia, the year following, with the eminent chemist, Benjamin Silliman, Sr., of New Haven, as President. This was followed by annual meetings in Boston, Albany, Washington, New Haven, New York, and again in Boston in 1847, under the succession of Presidents: S. J. Morton, Henry B. Rogers, John Lock, William B. Rogers, C. T. Jackson and William B. Rogers for a second time, all of whom were prominent in their respective lines of research and each of whom has left an honored mark on the annals of American science.

At the meeting of 1847 in Boston it was found that during the seven years of the existence of the Association the kindred sciences of mathematics, astronomy, physics, chemistry, geography and ethnology had gained many devotees in this country. Such advances had been made in these sciences as to show the necessity of broader views and more general coöperation among the workers in all departments of science. It was therefore resolved to enlarge the scope of the existing association and to

take in all the sciences by changing the name to The American Association for the Advancement of Science.

In 1848 the new association met in Philadelphia, the birth-place of its predecessor, and adopted the constitution which in all its vital points has remained unchanged to this time. The first clause of this constitution is as follows: "The objects of the Association are, by periodical and migratory meetings, to promote intercourse between those who are cultivating science in different parts of America, to give a stronger and more general impulse and more systematic direction to scientific research, and to procure for the labors of scientific men increased facilities and a wider influence." Acting under this clause the Association has held forty-three meetings in the following cities: Philadelphia twice (in 1848 and 1884), Cambridge, Charleston, New Haven, Cincinnati twice (in 1851 and 1881), Albany twice (in 1851 and 1856), Cleveland twice (in 1853 and 1888), Washington twice (in 1854 and 1891), Providence, Montreal twice (in 1857 and 1882), Baltimore, Springfield, Newport, Buffalo three times (in 1866, 1876 and 1886), Burlington, Chicago, Salem, Troy, Indianapolis twice (in 1871 and 1890), Dubuque, Portland, Hartford, Detroit, Nashville, St. Louis, Saratoga, Boston, Minneapolis, Ann Arbor, New York, Toronto, Rochester, Madison and Brooklyn.

At first it was contemplated to hold two meetings each year, one in the early spring, mainly in the Southern cities, and the other in the summer in the more Northern cities. Thus two meetings were held in the years 1850 and 1851, but no meeting was held in 1852. The large number of members connected with colleges and schools soon made it essential to hold the meetings annually during the summer vacation. In 1859 a meeting was held in Springfield, and in 1860 at Newport. The fifteenth meeting was to have been held in Nashville, but was sus-

pended owing to the unhappy condition of the country. Five years later the meeting was held in Buffalo, when 79 members rallied to revive the meetings which have since that time been annually increasing in importance and have been attended by from 200 to 1000 members according to special circumstances and to locality.

The Association has now about 2000 names on its roll of members, and it has called to its annual meetings the principal societies of a national character, which, largely as offshoots from the Association, hold annual meetings as affiliated societies in connection with the Association. During the existence of the Association there has been on its roll the name of nearly every man and woman of eminence in science in the country, as well as many others equally distinguished in literature and art; while hundreds of men and women have found in the membership of the Association the opportunity of increasing their knowledge by contact with professional workers in science, and have had their minds made broader and their lives more useful as a consequence. The influence of the Association, meeting as it does in various parts of the country, has unquestionably been of the greatest importance to the people in bringing scientific methods and results to their notice; and it is beyond question that many a young mind has been led to pursue a life of scientific research in consequence of incentives derived from these annual gatherings.

The men who have held the position of President since 1848 are such a guarantee of the high character of the Association and the diversity of its interests that it is well to mention the names of Rogers, Redfield, Henry, Bache, Agassiz, Pierce, Dana, Torrey, Hall, Caswell, Alexander, Lea, Barnard, Newberry, Gould, Foster, Hunt, Gray, Smith, Lovering, J. L. LeConte, Hilgard, Newcomb, Marsh, Barker, Morgan, Brush,

Dawson, Young, Lesley, Newton, Morse, Langley, Powell, Mendenhall, Goodale, Prescott, Joseph LeConte, Harkness, Brinton, Morley.

In 1874 the Association was incorporated by a special act of the Legislature of Massachusetts, and it has authority to hold both personal property and real estate. The official home of the Association is in Salem, Mass., where there is an office in charge of the Assistant Secretary, where are kept the publications of the Association and a scientific library of considerable importance. The proceedings of each meeting are published in an octavo volume of several hundred pages, containing the addresses of the President and Vice-Presidents, reports of special committees, and more or less extended abstracts of the two or three hundred papers read at the meeting. Besides the annual volume of proceedings, a quarto number of the memoirs has been published by the generous gift of Mrs. Elizabeth Thompson, the first Patron of the Association. Several volumes of the Association have been reprinted by the liberality of Mrs. Esther Herrman, General William Lilly and Mrs. Thompson, the three Patrons of the Association.

Members of the Association are elected by the Council after nomination by two members of the Association. Upon election members pay \$5 admission fee. There is an annual assessment of \$3 which entitles members to all the privileges of the meetings and to the annual volume of proceedings. From such members as are engaged professionally in scientific work, or have by their labors advanced science in any of its departments, the Council elects the Fellows on nomination from the sections. It is from the Fellows that all officers of the Association are chosen, and thus the management of the Association is kept in the hands of professional scientists, while its doors are open wide to all who are inter-

ested in its objects and wish to be benefited by participation in its meetings.

Any individual who may give \$1000 or more becomes a Patron of the Association. Any member may become a life member by the payment of \$50 at one time which exempts him from the annual assessment. The income of the \$50 is used for current expenses of the Association during the life of the member; afterward the principal is added to the Research Fund. The interest of this fund is devoted to encourage original research. The Research Fund now amounts to nearly \$6000. The first grant from this fund was made at the New York meeting in 1887 to Professors Michelson and Morley to aid them in their important researches for the establishment of a standard of length. From this fund, secured by small savings, the Association has already in eight years been able to make grants amounting to \$2200 in aid of important scientific research. The time will undoubtedly come when this fund will be greatly increased by the Association being made the almoner of patrons of science.

At the present time the Association is divided into nine sections as follows: A. Mathematics and Astronomy; B. Physics; C. Chemistry; D. Mechanical Science and Engineering; E. Geology and Geography; F. Zoölogy; G. Botany; H. Anthropology; I. Economic Science and Statistics. Each of these sections is presided over by a Vice-President of the Association, and each has its secretary and special committees.

During the week of the Association meeting, in any city, two free evening lectures are generally given by the Association complimentary to the citizens. The general sessions, the presidential address and the addresses of the nine vice-presidents, and all the meetings of the sections, are free to all who wish to attend.

The triumphs of science have been many and great. By it mankind has been bene-

fited and civilization advanced. Grand possibilities lead her votaries on in the hope of still greater achievements than any yet accomplished. The diffusion and advancement of scientific knowledge are the objects of the Association for the Advancement of Science.

F. W. PUTNAM.

Permanent Secretary, A. A. A. S.

*BOLOMETRIC INVESTIGATIONS IN THE
INFRA-RED SPECTRUM OF THE SUN.**

WHEN Sir Isaac Newton allowed a beam of light to fall upon a triangular bar of glass, and thus demonstrated the complexity of ordinary light, he undoubtedly rendered science a great service: but when he stopped there, and said that all transparent substances affected light both qualitatively and quantitatively alike, he did it an injury almost as great. The weight of his word deterred investigators and retarded the development of this branch of optics for very many years. At last it was shown that all transparent substances affect light differently. Some bend all the colors considerably out of their course, while scattering or 'dispersing' them but slightly. Others bend, or 'refract,' but slightly, and 'disperse' considerably. In general the violet is 'refracted' most, followed by blue, green, yellow, orange and red, which is refracted least. Similarly, Newton's advocacy of the theory that light is material particles, 'corpuscles,' thrown out from the luminous body, added to the difficulties of gaining a general acceptance of the rival theory, which sees in light only a periodic, or 'wave,' motion, in a hypothetical elastic medium. To-day every scientist accepts the undulatory, or wave, theory of light and is even striving to make it unite the phenomena of light and electricity in one common explanation.

Long after Newton's corpuscles had

passed out of science, 'caloric,' or the heat fluid, still maintained its list of respected advocates, and it remained for the first half of this century to relegate 'caloric' to the curiosity shop along with the 'corpuscles.' Then it was that heat was recognized as another manifestation of those periodic disturbances, or waves, in that elastic medium which was then known as the luminiferous ether, and which is now universally referred to as 'the ether.' In 1802 Wollaston, upon repeating Newton's experiment, discovered certain dark bands traversing the colors and apparently separating them. Some ten years later Fraunhofer made these bands the subject of very extensive and careful investigation, observing several hundred and mapping and naming the more important among them. These lines are commonly known now as 'Fraunhofer lines,' and are used as milestones in the spectrum. Thanks to the labors of Wollaston, Fraunhofer, Brewster, Angstrom, Kirchhoff, Bunsen and many others in less degree, we know that a chemical element, as sodium, when its vapor is heated sufficiently, will radiate only certain kinds of light; sodium, yellow; thallium, green; lithium, red, and so on. The light from any white-hot solid, when passed through a prism, is dispersed into a spectrum having all the colors and no dark lines, that is, a 'continuous spectrum.' If we put soda in an alcohol flame it will emit yellow light, which, being sent through a prism, will not give a continuous spectrum, but only a band of yellow at that place where the yellow would come in a continuous spectrum. Now, if the light of a white-hot solid, electric arc-light, for example, be caused to pass through the soda flame and then be dispersed into a spectrum, we shall find the latter to be continuous, except for a dark band at exactly that part of the yellow where the soda flame gave a yellow band. The soda vapor in the alcohol flame absorbed out of the white light just

* Part of a popular lecture under the auspices of the New York Academy of Sciences.

that kind of light which it can itself radiate. (Kirchhoff's law.) In the spectrum of sunlight we find a Fraunhofer line at just the same point as the dark line occurs when the white light is passed through the soda vapor. The more exact the measurement the more perfect is the coincidence, hence we are compelled to conclude that the light from the white-hot body of the sun has passed through hot soda vapor before it reached our prism; this must have been in the sun's atmosphere, therefore sodium must exist in the sun. The reasoning is analogous and even more convincing that hydrogen with three lines is there, iron with its many hundred, and so of many other of the elements known to us. Some of the Fraunhofer lines do not correspond to any of our elements, but may be identified at any moment, as, for example, those of the recently discovered argon and helium.

The question was soon raised, whether the energy stopped sharply at the red and violet, or extended into the invisible. So-called fluorescent substances soon found something, 'actinism,' beyond the violet, and the thermometer soon found heat beyond the red, and thus began the campaign into the unknown invisible regions of the 'ultra-violet' and the 'infra-red.'

A word as to the size of these little waves and their rapidity of vibration. They are so small that for their measurement a special unit was adopted. The 'micron' (short) is $\frac{1}{1000}$ of a millimeter, or $\frac{1}{254000}$ of an inch, and is usually represented by the Greek letter mu, μ . A 'wave' whose length, including both hill and valley, is 0.75μ ($\frac{75}{2540000}$ inch), and which vibrates only about four hundred thousand million times per second, produces the sensation of red in our eyes. If the rate is seven hundred million times per second and the length about 0.43μ ($\frac{43}{2540000}$ inch) the sensation will be violet. Between these limits the sensations are the various reds, oranges,

yellows, greens and blues. Beyond these extremes the vibrations have no visible effects upon our eyes.

Photography in the trained hands of Victor Schumann, of Leipzig, has carried the frontier in the ultra-violet out to a wave length of 0.12μ , or a distance more than equal to the whole visible spectrum from red to violet. Meanwhile the 'bolometer,' with the consummate manipulation of S. P. Langley, has forced the limits of the infra-red to 10.0μ , with good assurances of waves two or three times as long as that, giving us an infra-red spectrum at least twenty times as long as the entire visible one from violet to red.

Metals on being heated increase their resistance to the passage of an electric current; in this fact lies all the secret of success in infra-red spectrometry. Wheatestone devised a system of electrical connections with battery and galvanometer, which compares resistances just as a lever balance compares weights. (See Fig. 1.) Let us

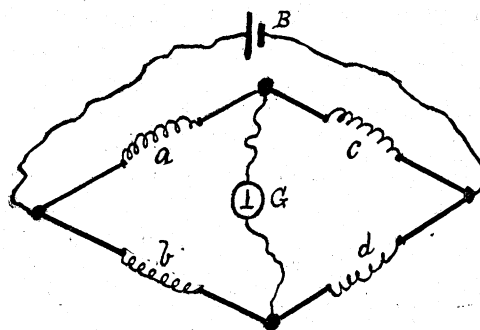


FIG. 1. Diagrammatic representation of the connections of a Wheatstone bridge; *a*, *b*, *c*, *d*, are the four resistances; *B* the battery and *G* the galvanometer.

suppose two very thin strips of metal to be so arranged in a Wheatstone balance (or 'bridge' as it is called) (See Fig. 2); when the adjustment is correct no current will run through the galvanometer, and the beam of light reflected from the little mirror attached to the 'needle' re-

mains stationary. If one of the strips be now warmed, ever so slightly, its resistance will be increased, the balance is destroyed, a current of electricity traverses the galvanometer and the beam of light is deflected from its normal position (zero). The de-

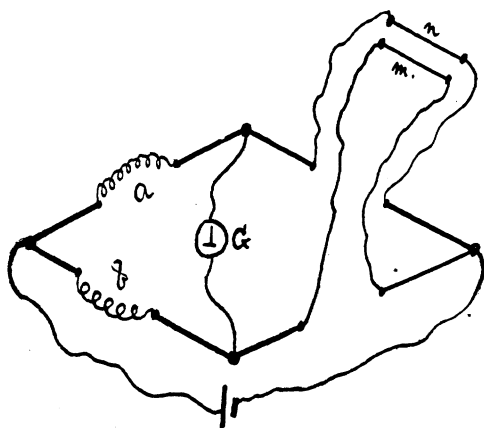


FIG. 2. Diagram of Wheatstone bridge showing how the two resistances *c* and *d* are replaced by the 'side arm' *n* and the 'middle arm' *m* of the bolometer.

flection is a measure of the heating of the strip, and the position of the spot of light upon a scale always tells the thermal condition of the strip. Such a pair of strips, fitted with many devices and special adaptations, constitutes a 'bolometer.' One strip, called the 'central arm,' is exposed to the radiations to be measured, while the other, 'side arm,' is carefully shielded therefrom. The exposed strip of a bolometer for spectrum work is about 8 mm. long, $\frac{1}{20}$ mm. wide, and $\frac{1}{8000}$ mm. thick ($\frac{1}{3} \times \frac{1}{8000} \times \frac{1}{8000}$ inch) appearing like a fine hair. Of course the galvanometer is the most delicate, and all precautions are taken. Such a system will record a rise in temperature of one of its strips of less than $\frac{1}{1000000}$ of a degree centigrade ($\frac{1}{8000000}$ Fh.)

Professor Langley's pioneer work into the infra-red regions of the spectrum was all by visual observations with the bolom-

eter. Let us suppose that some invisible Fraunhofer line is to be located. A large clockwork arranged to rotate a mirror is so adjusted that it reflects a beam of sunlight upon the slit of the spectrometer, which then gives a distinct spectrum, with its lines visible and invisible. The bolometer, mounted upon the arm of the spectrometer, is so set that its central arm coincides with some visible Fraunhofer line, and the circle of the spectrometer is read. This is the starting point. The arm is then turned until the bolometer stands where a line is sought. Again the circle is read. The slit of the spectrometer is then closed and the position of the spot of light at the galvanometer is noted. The slit is opened and the galvanometer read, then the slit is closed and the galvanometer read. The average of the first and third galvanometer readings subtracted from the second gives the deflection due to the radiant energy falling upon the bolometer at that particular point in the invisible infrared spectrum of the sun. The arm is now moved forward a little, bringing the bolometer into a new part of the spectrum. Again a series of deflections are read and the energy measured. Thus hundreds and thousands of points in the spectrum are determined; and these, when plotted, show the deep valleys where the energy runs low and the hills where it is abundant. In this way Professor Langley and his assistants, with consummate patience and perseverance, felt over the long stretches of the infra-red, mapping a beautiful 'energy curve,' with its many little notches and its four or five huge valleys separated by high peaks.

Some time after Prof. Langley's advent in Washington he organized an astrophysical observatory and in it has prosecuted his investigations by a new method and with renewed enthusiasm. The essential principles of the operation remain the same,

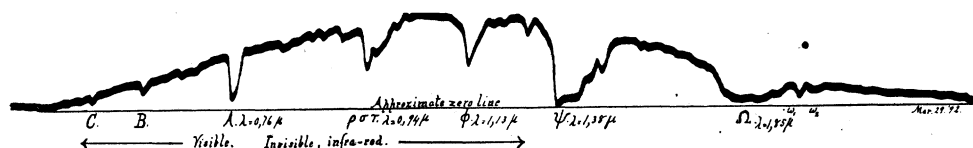


FIG. 3. One of the first bolographs, made in six minutes. A curve where the abscissae depend upon the wave-lengths of the undulations; and each ordinate is the amount of energy of the wave-length represented by the corresponding abscissa. C, B and A are the visible Fraunhofer lines; $\rho\sigma\tau$, ϕ , ψ , Ω , and ω_1 , ω_2 are absorption bands in the infra-red. λ stands for wave-length.

only the record is automatic. The spot of light reflected from the mirror of the galvanometer no longer falls upon a scale, but upon a photographic plate which is raised or lowered by a clockwork. The same mechanism drives the tangent screw of the spectrometer, thus slowly swinging the bolometer through the spectrum. Now the operation is as follows: When all the adjustments have been made, the reading of the circle is noted at the starting point. At the signal the slit is opened, and a few seconds later the clockwork is set in motion, swinging the arm and lifting the plate. So long as the bolometer receives the same quantity of energy the spot of light remains stationary and traces a vertical line upon the rising plate. If the bolometer encounters an absorption band it cools off and the spot of light moves to one side, making a break in the trace. If it encounters a warm region the deflection will be in the opposite direction, and so on. The bolometer strip, as it sweeps through the darkness beyond the red, traverses regions varying in their quantities of heat, and continually reports its condition by the deflections of the spot of light, which is recorded in an irregular line upon the plate until at the signal everything stops, and in ten minutes an energy curve has been traced, better in nearly every respect than Prof. Langley's first one, which represents thousands of tedious observations. (See Fig. 3.) By this method, in a few hours of good work, curves are obtained which show hundreds of lines where dozens were intimated before. (See Figs. 4

and 5.) One must have seen it to appreciate the fascination of watching that simple spot of light and seeing in one's thoughts that little strip climbing up the heights of energy mountains only to plunge

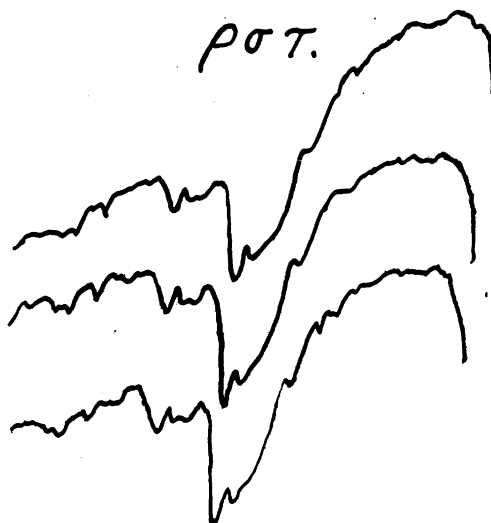


FIG. 4. Three bolographs of the infra-red group $\rho\sigma\tau$ showing how well different records agree, even in detail.

into a cold abyss upon the other side, absolutely unerring, overlooking no trifling hillock, overestimating no lofty peak.

When desired, such energy curves can be converted into 'line-spectra,' similar to the photographs of the visible Fraunhofer lines. Such a line-spectrum, combined with Schumann's photographs of the ultra-violet and Rowland's of the visible spectrum, upon Rowland's scale, would give us a radiant energy spectrum about six hundred feet long.

Of what use is all this? Could Faraday foresee that Morse would invent the telegraph or Bell the telephone? Could Helmholtz or König foresee the phonograph? Fortunately we live at a time when any addition to the world's knowledge of nature's truths is sufficient justification for any investigation however laborious.

The bolometer has already taught us that the firefly is a dozen times more economical as a light producer than our best electric



FIG. 5. A bolograph of the sodium double yellow line indicating the nickel line between them. This will show the extreme delicacy of this method of feeling and recording absorption lines.

lights and a hundred times better than our gas. It has taught us that our atmosphere acts like a valve, transmitting in almost undiminished strength the short quick waves of energy radiated to us from the sun, but refusing absolutely to return the long slow waves in which the earth tries to radiate the energy back into space. Without this atmosphere we should all have been frozen long ago.

We now know of electric waves which behave in every respect similarly to those of light, but which are many times longer and slower. Almost every month brings the announcement of shorter and faster electric waves, while Prof. Langley and his fellow laborers are continually detecting longer and slower light waves. Thus the boun-

daries of our knowledge are forced forward, and the unexplored strip becomes ever narrower. Light is as it were the snowy cap of a mountain. One explorer pushes downward from the light top into the dark regions lying below, while another from the broad and fertile valley of electricity struggles upward into the unknown. Are the two upon the same mountain? Will they ever meet? We hope so, we believe so, but until they have clasped hands we are not satisfied. Other workers may be found to be upon the same ether mountain, gravitation and other mysteries may there find a solution. What is above our mountain, unencumbered ether? thought? life?

WILLIAM HALLOCK.

COLUMBIA COLLEGE.

VERTEBRATE PALEONTOLOGY IN THE AMERICAN MUSEUM.

THE American Museum of Natural History has recently acquired the collection of fossil mammals, made by Professor Cope between 1872 and 1895. The collection represents eleven geological horizons, including specimens from the Jurassic, Laramie (Cretaceous), Puerco, Wasatch, Wind River, Bridger, Washakie, White River, John Day, Loup Fork and Pleistocene. The collections from the John Day and Wasatch of New Mexico and Wyoming are exceptionally perfect, and that from the Puerco, together with the collection already in the Museum procured by the expedition of 1892, is unique. Four hundred and seventy species are represented, of which four hundred and two are types. The collection is representative of all of Professor Cope's researches upon the mammalia, with the exception of the greater portion of his work upon the Wheeler Survey, the types of which are contained in the Smithsonian Institution of Washington, and more recently of his work upon the Canadian and Texas Surveys. The most complete speci-

mens are the skeletons of *Hyracotherium* and *Phenacodus* from the Wasatch and of *Hyrachyus* from the Bridger. There are also skeletons of *Galecynus* and *Trispondylus*, and material for the restoration of several other animals. Professor Cope has reserved the right of describing the new material, but the entire collection will be arranged and placed on exhibition as rapidly as possible, and will be permanently known as the Cope Collection. A large new storeroom on the upper floor of the new wing of the Museum has been set apart especially for it. All the specimens will be numbered; the types designated under the direction of Professor Cope, and all information regarding localities, dates, description, etc., will be entered on a special card catalogue. The collection will thus be made readily accessible to students.

The Exhibition Hall on the third floor of the new wing of the American Museum has been designed and cased for the entire collection of fossil mammals, and will be opened for exhibition in November. The line of large cases on either side of the centre of the hall is designed for complete mounts of *Aceratherium*, *Metamynodon*, *Palaeosyops* and *Titanotherium* and other animals now in preparation. The smaller side cases will contain morphological exhibits of the evolution of members of the families; also cases arranged geologically to represent the faunæ of each horizon; and a series of upright A cases designed for the exhibits of the evolution of the teeth, feet, skull and other special parts of the skeleton.

The expedition of 1895, the fourth which has been sent out, entered the Uinta beds early in the spring and explored the three levels in which the Uinta deposits are divided, as late as the water supply admitted. The party was then reinforced by a photographer, and, under the direction of Dr. Wortman, moved north to the southern exposure of the Washakie basin, east of the

Green River, and is now working in the *Uintatherium cornutum* beds with considerable success. The work of these expeditions is not confined to the collections of fossil mammals, but to the careful survey of the successive depositions in these various basins. Every basin visited is explored with the greatest care to determine the vertical succession and horizontal distribution of species. The main result of this exploration is to prove that each of the larger subdivisions of Leidy, Cope and Marsh is capable of being divided into a number of successive stratifications or beds, distinguished by characteristic species. The application of this method was begun by the Princeton expedition of 1880 in the surveys of Professor McMaster, but unfortunately was not followed up with sufficient care. Several years ago Mr. J. B. Hatcher showed that the lower portion of the White River beds was capable of subdivision into three clearly defined levels, and the American Museum party of 1893-94 proved that above the *Titanotherium* beds five other specific levels could be determined, thus dividing the White River beds into eight levels. In 1894 the Uinta beds were proved to be distinctly divided into three levels, the older of which overlaps the somewhat older Washakie beds, and the uppermost overlaps the beds of the more recent White River beds, thus demonstrating that the Uinta is the complete link between the Middle Eocene and the Lower Miocene or Oligocene. This summer the party is endeavoring to determine the exact relations of the Washakie depositions to the somewhat older Bridger deposition west of the Green River.

HENRY F. OSBORN.

THE GEOGRAPHICAL DISTRIBUTION OF THE
MOLLUSCA.

WE hear a great deal of late concerning the habits, range of variation, and special characteristics of a great number of forms

of life; but very little is written concerning the methods by which species peculiar to one locality may be transported to others many miles distant. This is a subject which bears more closely on the origin of species than any other, and one which will yield some of the best results, if studied carefully and faithfully, and if original observations are made in the field. It is my purpose in this communication to briefly consider some of these transporting agencies as illustrated by the Mollusca, from facts gathered by myself while collecting in the field, and from reliable correspondence.

Distribution by the aid of birds.—Several years ago, while on a collecting trip to Florida, I took occasion to dissect several hundred migrant and resident birds and to carefully note the contents of their crops. In a large number of the crops I found the shells of mollusks which had been taken as food; these shells were mostly minute, and of the genera *Pupa*, *Amnicola*, *Pisidium* and *Vertigo*. These shells, being indigestible, and not affected by the gastric juices of the stomach, would naturally pass off with the fæces. In this manner, the shells of many species of mollusks, which were once supposed to inhabit restricted localities, have been found at a great distance from their recorded habitats. Especially would this be true during the migratory season, when a bird would swallow a species in one State and drop the shell with the fæces in another. The shells, of course, would in most cases be dead when dropped, the animal portion being used as food; but there are exceptions to this, for I have several authentic accounts of living mollusks being found in the stomachs of birds. As an example of the wide distribution of these small mollusks, I cite *Pupa armifera*, Say, which is found from Dakota and Kansas to the Eastern States and Mexico.

The Catbird (*Galeoscoptes carolinensis*) I found to feed only (so far as the Mollusca

were concerned) on the minute land snails *Pupa* and *Vertigo*. It was frequently observed on the palmetto trees searching for these minute animals. The hawks and kites of Florida, especially the Everglade Kite, seemed to consider the animal of *Ampullaria depressa*, Say, a great delicacy, for in almost every crop dissected I found the remains of this mollusk. Heaps of the dead shells of this animal were always found beneath their roosting places. Frequently a hawk or kite will capture this fresh-water snail and carry it several miles to its roosting place; but many times another bird will overtake the one carrying the booty, and a dispute of ownership will follow, which nearly always results in the loss of the prey, which drops unharmed, perchance, into a pond which this species has not before inhabited, and there, if laden with eggs, as is frequently the case, establishes a new colony of *Ampullaria*. By this means, as well as others, this species has been distributed over a great portion of Florida. It is my belief that many a colony of mollusks, as well as other animals, has been formed in this manner.

Ducks, geese, swans and many other kinds of wild fowl, are very fond of snails, and I have never failed to find the remains of them in their crops. By means of these birds the shells of many mollusks have been transported for many miles, and have offered, doubtless, material over which some conchologist has worried and finally described them as a new species! I know of several instances where the eggs of a mollusk were found attached to the foot of a mallard, and several birds have come under my notice, which, when shot, had young Anodons and Sphæriums adhering to their toes. Many other instances might be cited of this character, but enough has been said to show that birds exert a wide influence in the distribution of the mollusca.

Distribution by the aid of fishes.—Various

species of fish feed upon snails as a regular diet. After feeding in one spot they repair in schools to some particular spot, often many miles distant from the feeding ground, where they digest the animal and eject the shell, either through the mouth or with the fæces. In this manner litoral mollusks are carried to the abyssal regions, and, I believe, have been described as deep-sea forms. The greater portion of the foregoing accounts relate only to the dead shells which have been ejected from the stomach of some vertebrate animal, and the change cannot be said to be a correct variation in habitat, save in the few cases cited where the living animal was transported; it is simply the dispersal of a skeleton from one point to another.

Dispersal of the living animal by means of insects.—It would hardly be supposed that insects could in any way be the means of distributing mollusks, and yet I have numerous records of such distribution. Some time ago a water beetle was captured, which had a *Sphærium* attached to one of its legs; another species was captured with an *Ancylus* attached to its wingcase. I have records of other instances where the larger water beetles had specimens of *Physa*, *Planorbis*, and even *Limnæa* attached to different portions of them. In this manner living mollusks have been transported from one pond to another, and so many of the fresh-water species have been distributed by the humble means of a water beetle.

Distribution by means of storms, ocean currents, etc.—We may now consider a change of habitat which affects the living animal more closely than in the cases previously cited. Many portions of Florida bordering the rivers and creeks are continually falling away and being carried into the Gulf, and so to Cuba, Yucatan and other parts of the West Indies and Mexico. These transported masses consist of three trunks, entwined vines, branches and roots of trees

covered with earth and vegetation. Many times, during storms, whole tracts of land are washed away and portions of them of considerable size are carried many miles by the currents. Upon all of these natural rafts, mollusks are found which are transported to habitats a great many miles from those in which they first appeared. In this manner *Helices*, *Bulimi*, *Pupæ*, *Limnæa*, *Physa*, *Planorbis*, and a host of species too numerous to mention, are carried from the Southern States to Cuba, Mexico and Yucatan. No doubt many of the species of land and fresh-water shells found in Cuba which are also found in the Southern States, especially Florida, were carried there in this manner, or were carried from Cuba to the States.

In the Western States fresh-water and land shells are continually being carried from one point to another. In the early spring, when freshets and floods occur, the young fry, as well as the adult animals, are carried from the headwaters of the Mississippi River to various places along its banks upon driftwood, tree trunks and an innumerable number of natural rafts of this character. In this manner the species of *Unio* have reached a comparatively wide distribution. So also in our Great Lakes the fry of mollusks are carried from Huron to Ontario. Mountain streams, during freshets, are potent vehicles of transportation in the spring, and no doubt many mollusks living at high altitudes are carried by this means from the mountains to the valleys and plains below. As an example of this I cite the following case, furnished by a reliable correspondent: About two years ago a colony of *Vittrina limpida* was found in a Pennsylvania town just after a severe flood; the species had not been before observed, although the collector had searched the locality for several years preceding. These shells had undoubtedly been brought down the Alleghany River on rafts during the flood, and the little colony

had been formed. From last accounts the little colony was doing well. This is but one example of many which prove that mollusks are distributed in this manner. I have one authentic case of a number of Anodons being carried away by a whirlwind and falling several miles distant during a severe rainstorm.

Distribution by human agencies. Man has been a great factor in the distribution of all animal and vegetal life, and the Mollusca are no exception to the rule. The great Erie Canal has been a powerful transporting agent. In it we find species of *Physa*, *Limnæa* and *Planorbis*, which were once supposed to inhabit only the western lakes and rivers. Even European species, like the giant *Limnæa stagnalis*, have been brought over from Germany and France, and are now found from Illinois to New York; so also with several small *Valvatas* and *Amnicolas*. Land mollusks have also been brought from Europe, either adult or in the egg, and we now have several colonies of *Helix nemoralis* and *H. hortensis* in several parts of the United States. In the City of Mexico, in a little corner of the cypress grove at Chapultepec, is a large colony of *Helix aspersa*, which, up to the time of its discovery, in 1890, was not supposed to be found in Central America. It is now spreading over the valley of Anahuac, and will before long be a recognized part of the fauna of Mexico. This species was undoubtedly brought to Mexico with German goods, found a locality favorable to its existence, and has grown and multiplied. This same species is now found in Charleston, South Carolina; New Orleans, Louisiana; Portland, Maine; Nova Scotia; Santa Barbara, California; Hayti; Chili; etc. It is a curious fact that *Helix hortensis* was not accidentally introduced into the country, as were *H. nemoralis* and *H. aspersa*, but was first brought to Burlington, New Jersey, by Mr. W. G. Binney. This species does not

thrive so well, nor does it spread so rapidly, as did the other species mentioned.

Our large garden-slugs, *Limax maximus* and *L. agrestis*, were introduced into this country some fifty years ago, and are now found all over the northeastern part of the United States and parts of Canada. The transportation of hothouse plants has been the principal means of distributing these species, for they are found more abundantly in greenhouses than in any other locality. Geological changes also tend to disperse mollusks and also to change their mode of living. A single example will suffice to illustrate this point. In Africa there is a lake (Lake Tanganyika) in which live a number of mollusks almost identical in the form of the shell and animal with the marine group of shells known as Trochids; yet these mollusks live in fresh water and have the principal characteristics of fresh-water species. Now this lake must at some time have been connected with the sea, and the change from salt to fresh water must have been very gradual in order not to have killed off all the animals. Numbers must have died during the change, and those that were the most enduring lived and multiplied. The result of the change is some of the most curious mollusks known to science. (*Limnotrochus*, *Tiphobia*, *Neuthauma*, *Tanganyicia*, etc.)

And thus I might go on and give hundreds of examples of the distribution of mollusks by natural and artificial methods; but I believe I have given enough to illustrate my point, which is that there is nothing so very wonderful in the finding of species hundreds of miles from their supposed natural habitat, and that the apparent 'paradox' of their discovery can be accounted for by some one of the examples given above. More attention should be given to the careful recording of facts such as those I have given, which are to my

mind far more valuable to science than the indiscriminate description of new species and genera, and a multitude of such facts would aid very materially in the solution of the origin of species, and the reasons for the gradual change from one type to another.

FRANK C. BAKER.

THE CHICAGO ACADEMY OF SCIENCES.

CURRENT PROBLEMS IN PLANT MORPHOLOGY (I.)

THE QUESTION OF PTERIDOPHYTE PHYLOGENY.

If the question be asked: which among living genera of Pteridophytes most closely resembles the hypothetical archetype, three answers are at hand. Goebel, of Munich, adheres to the Prantlian theory that *Hymenophyllum* of the leptosporangiate ferns may be regarded as primitive. The peculiar strength of this position lies in the apparent homologies between the filamentous prothallia of this fern and moss-protonema such as that in particular of *Buxbaumia*. Bower, of Glasgow, has brought forward for consideration the curious club moss *Phylloglossum* and constructs, under his strobilar hypothesis, a phylogeny passing from Lycopodiaceæ through the eusporangiate ferns to the leptosporangiate, practically an inversion of the older view. Campbell, of Leland Stanford, has argued ably the claims of the eusporangiate fern *Ophioglossum*, deriving from its region the Marattiaceæ, Isoetaceæ, Lycopodiaceæ and leptosporangiate series of ferns.

The three views may really be reduced to two; Goebel maintains a leptosporangiate origin for the group; Bower and Campbell would establish an eusporangiate origin. Therefore one view is quite exactly the converse of the other. The peculiar strength of the new position lies in the remarkable sporophytic homologies which have been indicated between *Anthoceros* of the Hepaticæ and *Marattia* and *Lycopodium*.

At present the German school labors

under a certain disadvantage, although the position of Dr. K. Goebel is in accord with the new ideas of mechanomorphosis developed in the rough long ago by Sachs and De Bary and lately carried forward by Sachs, and among zoölogists by Roux, Driesch and many others. The disadvantage consists in a necessary opposition to the well-established hypotheses of differentiation, an opposition in which an actual metamorphosis of embryonic rudiments (*Anlagen*) is maintained. Bower's theory of sterilization, than which nothing could seem more reasonable under the generally accepted interpretations of ontogenetic and paleontologic records, must be set aside, and, finally, little use can be made of the remarkable pteridophytic characters of the *Anthoceros* and *Notothylas* sporophytes; but one must turn away from this group and bring forward the more specialized mosses as archetypal plants.

Hugo Glück, in *Flora* 80: 303-387, 1895, under the title *Die Sporophyll Metamorphose*, gives a valuable census of anatomical resemblances between sporophylls and foliage leaves, and after an examination of sporangial protective apparatus, viz., hairs, pits, indusia, rolled-over margins, etc., of sporophyll petioles, and of various transitional forms, proposes as established the thesis that 'all sporophylls are metamorphosed foliage leaves.' This is almost exactly the converse of the Bower-Campbell position which maintains the derivation of non-sporangium-bearing leaves from a sporangial tract. The argument of Glück is by no means convincing, for his evidence, apparently, might be used with quite as much force on the other side.

Goebel, carrying the war into Africa, brings out a paper entitled '*On Metamorphosis in Plants*' in *Science Progress* 3: 114-126, 1895, which expresses his views tersely and clearly. The outcome of the debate is interesting, for it promises to resolve itself

into a struggle between the older evolutionary and the newer developmental mechanical interpretations of morphology. It is difficult to see how the Bower sterilization theory can be overturned without carrying with it the whole scheme of Archeogoniate phylogeny which plant morphology owes to the classic work of Hofmeister. Nothing can be more apparent under accepted beliefs than that from *Oedogonium* sporophytes upward there is a progressive change from an entirely sporogenous plant body to one in which the great part of the sporogenous tissue is replaced by sterilized areas. It is, however, possible that both differentiation and the 'true metamorphosis' of Goebel have gone on together in the phylogenetic series. The experimental method would doubtless throw more light on the whole matter than the speculative phosphorescence which, up to the present, has been the chief illumination.

CONWAY MACMILLAN.

SCIENTIFIC NOTES AND NEWS.

AUSTRALASIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE Seventh Session of the above Association will be held in Sydney, from the 3rd to the 10th January, 1897, under the Presidency of A. Liversidge, M. A., F. R. S., Professor of Chemistry, University of Sydney.

The Presidents and Secretaries of the Sections are as follows:

Astronomy, Mathematics and Physics.—R. L. J. Ellery, C. M. G., F. R. S., Government Astronomer, Vict., President; R. Threlfall, M. A., Professor of Physics, and J. Arthur Pollock, B. Sc., Demonstrator in Physics, Sydney University, Secretaries.

Chemistry.—T. C. Cloud, A. R. S. M., F. G. S., Manager Wallaroo Copper Works, South Australia, President; W. M. Hamlet, F. C. S., F. I. C., Government Analyst, N. S. W., Secretary.

Geology and Mineralogy.—Captain F. W. Hutton, M. A., F. R. S., F. G. S., Director of Canterbury Museum and Lecturer in Geology, Christ Church, New Zealand, President; T. W. E. David, B. A., F. G. S., Professor of Geology and Physical Geography, Sydney University, and E. F. Pittman, A. R. S. M., F. G. S., L. S., Government Geologist and Lecturer in Mining, Sydney University, Secretaries.

Biology.—T. J. Parker, B. Sc., F. R. S., Professor of Biology, Otago University, Dunedin, New Zealand, President; W. A. Haswell, M. A., D. Sc., F. L. S., Professor of Biology, Sydney University, and J. H. Maiden, F. C. S., F. L. S., Curator, Technological Museum, Sydney, and Superintendent of Technical Education, N. S. W., Secretaries.

Geography.—H. S. W. Crummer, Secretary of the Royal Geographical Society of Australasia, N. S. W. Branch, Secretary.

Ethnology and Anthropology.—A. W. Howitt, F. G. S., Secretary for Mines, Vict., President; John Fraser, B. A., LL. D., Sydney, Secretary.

Economic Science and Agriculture.—R. M. Johnston, F. L. S., Government Statistician, Tasmania, President; Walter Scott, M. A., Professor of Greek, Sydney University, and F. B. Guthrie, F. C. S., Consulting Chemist to the Department of Agriculture, N. S. W., Secretaries.

Engineering and Architecture.—H. C. Stanley, M. I. C. E., Chief Engineer, Southern and Western Railway Lines, Queensland, President; J. W. Grimshaw, M. Inst. C. E., M. I. Mech. E., &c., Supervising Engineer, Harbors and Rivers Department, N. S. W., Secretary.

Sanitary Science and Hygiene.—Hon. Allan Campbell, M. L. C., L. R. C. O., South Australia, President; J. Ashburton Thompson, M. D., Chief Medical Inspector, Board of Health, N. S. W., Secretary.

Mental Science and Education.—John Shir-

ley, B. Sc., District Inspector of Schools, Brisbane, Queensland, President; Francis Anderson, M. A., Professor of Logic and Mental Philosophy, Sydney University, Secretary.

Communications and papers for the meeting, or inquiries, may be addressed to the Permanent Hon. Secretary, The Chemical Laboratory, The University, Sydney, N. S. W.

THE GEOLOGICAL SOCIETY OF AMERICA.

THE seventh summer meeting of this Society will be held Tuesday and Wednesday, August 27th and 28th, in the Art Museum, Springfield, Mass. The Council will meet Monday evening, August 26th, and the Society will be called to order on Tuesday morning at 10 o'clock. The preliminary list issued on July 30th includes papers by George M. Dawson and R. G. McConnell, C. H. Hitchcock, Warren Upham, H. L. Fairchild, B. K. Emerson, N. H. Darton, Arthur Hollick, George P. Merrill, Wm. H. Hobbs, A. Capen Gill, C. H. Gordon, J. F. Kemp, J. C. Branner, W. M. Davis, C. R. Van Hise. The excursions arranged include one of a week, beginning Tuesday, August 20th, through the crystalline area of western Massachusetts conducted by Professors B. K. Emerson and Wm. H. Hobbs, and three shorter excursions during the week of the meeting: (1) To the crystalline rocks west of the Connecticut River, under the direction of Prof. W. O. Crosby. (2) To the Triassic sandstones, including a visit to Mount Tom and Mount Holyoke, under the direction of Professor B. K. Emerson. (3) To Meriden and Southington, Conn., under the direction of Professors W. M. Davis and William North Rice.

THE WORK OF YALE OBSERVATORY.

IN the report for the year 1894-5 presented by the board of managers of Yale University to the President and Fellows,

Dr. Elkin states that he has continued and brought to what he hopes is a final close the series on the parallaxes of the first magnitude stars, and hopes to present the definitive results in the near future. The series on the parallaxes of the large proper motion stars, on which Dr. Chase has been mainly engaged, now comprises 99 stars, all but two of which have been observed at two parallax maximum epochs, in general on three nights. Measures of the Moon's diameter at the total eclipse of March 25th, last, and measures of Mercury referred to the Sun's limb at the transit on November 10th, last, were attempted, but in both cases the state of the sky permitted our obtaining only a small amount of results. The reductions of the *Coma Berenices* triangulation have been practically completed, and the work will shortly be ready for the press. The new equatorial mounting constructed by Warner & Swasey for carrying a number of cameras was used on three nights of the August meteor period, but only two meteor trails were found on the plates. The observatory has, however, twelve impressions of Perseid trails, and plates showing meteor trails have been sent by Professor Barnard and Professor Pickering, a discussion of which Dr. Elkin will shortly have ready for publication.

GENERAL.

It is hoped that Professor W. M. Davis will give one of the lectures on the part of the American Association complimentary to the citizens of Springfield. In this case his lecture would be upon the geographical development of the Connecticut Valley and would be illustrated by lantern pictures. The other lecture will probably be by Mr. Cornelius Van Brunt, on the Wild Flowers of the Connecticut Valley, illustrated by colored lantern pictures of the flowers and plants. The local committee contemplate offering a room free of

expense for the exhibition of scientific apparatus, specimens, etc. The railroads generally are making reductions on the plan of one rate and a third for the round trip, but unfortunately no reductions have as yet been made for railroads west of the Mississippi. Members from the West can, however, secure the reduction from points east of the Mississippi.

A CIRCULAR issued by Mr. William Kent, Vice President, and Prof. Harold S. Jacoby, Secretary of the Section of Mechanical Science and Engineering of the A. A. A. S., recommends that the papers read before the Section relate more especially to the application of scientific methods to the various engineering problems, while the more strictly technical subjects and the description of finished projects which appeal only to one branch of engineers belong rather to the different engineering societies. It has been suggested that short papers be presented giving information regarding the following questions: Have you any experimental data which either confirm or throw doubt upon formulas or constants hitherto generally received? Have you any data upon subjects hitherto considered doubtful, as, for example, the strength of unstayed surfaces? What subjects should engineering laboratories undertake to investigate, with a view to obtaining data which will be of general importance, and how would you propose to make such tests (including a description of the apparatus)? It is hoped that many brief resums of investigations or experiments relating to different subjects of interest to the Section may be offered for this meeting.

It was announced in the preliminary circular of the A. A. A. S. that the State Weather Service Association would meet in Springfield, Mass., but it is now found impracticable to meet with the A. A. A. S., on account of the difficulty in securing representation of the various State services,

three of the four preceding State Weather Service Conventions having been held in Eastern cities. Indianapolis, Ind., has therefore been selected for the place of meeting this year, and a large attendance of State Weather Service Directors is promised. The convention will be held October 15th and 16th.

THE Linnæan Society of New York has published the abstract of its proceedings for the year ending March 26, 1895. There were held during the year 14 meetings of the Society, at which the average attendance of members was seven and of visitors six. There were read 16 papers, of which nine related to ornithology and the remainder chiefly to mammology. The officers elected for the ensuing year are: President, J. A. Allen; Vice-President, Frank M. Chapman; Secretary, Walter W. Granger, and Treasurer, L. S. Foster. There are appended to the proceedings two papers, one by Dr. Juan Gunlach, entitled 'Notes on Cuban Mammals,' and one by Mr. W. L. Sherwood, on 'Salamanders found in the Vicinity of New York City, with Notes upon Extra-limital or Allied Species.'

PROFESSOR MENDELÉEFF will visit London during the present month, in connection with the work of making standards of Russian weights and measures.

IN England Mr. James Blyth, the well-known agriculturist, has received a baronetcy, and Mr. Herbert Gardner, President of the Board of Agriculture, has been made a peer.

A STATUE of M. Boussingault has been erected in the Court of the Conservatoire des Arts et Mètres in Paris, in which institution he was professor of agricultural chemistry for forty years.

THE *Medical Record* states that The Charcot Monument Fund now amounts to over 40,000 francs, nearly half of which sum has been contributed by foreigners.

It is proposed to commemorate the fiftieth anniversary of Professor Leuckart's doctorate. American students who have studied zoölogy under Professor Leuckart at Leipzig and who wish to contribute to the memorial—which will be a marble bust—should send subscriptions to Herrn Karl Graubner, Johannes Gasse 8, Leipzig.

SIR JOSEPH LISTER has been presented with a portrait of himself painted by Mr. Lorimer as a testimonial from his colleagues and pupils on his retirement from his chair in King's College Hospital. Speeches were made by Dr. W. S. Playfair, who presided, and Sir John Ericksen.

It is proposed to erect a statue in Copenhagen to the memory of Dr. Hans Wilhelm Meyer. Subscriptions may be sent to Mr. A. E. Cumberbatch, 80 Portland Place, London, W.

THE citizens of Geneva have petitioned that the statue of Carl Vogt, the work of M. de Niederhausen, be placed in the open air on the Promenade des Bastions instead of in The Vestibule of the University.

SIR WILLIAM FLOWER, Professor W. Ramsay and M. Sabatier have been elected correspondents of the French Academy.

The Photographic Times for August contains an admirably illustrated article on Astronomical Photography by Professor E. E. Barnard. A number of full-page reproductions are given of photographs with exposures as long as five hours.

WE quote from the *Lancet* the outlines of a plan having for its object the continuation of the Index Medicus: "The yearly cost of production is about £1,000 and it is proposed to raise this sum by 200 subscriptions of £5 each. The United States, it is estimated, will supply 120, Great Britain 60, and the Continent 20. We think, however, that Great Britain with all her learned societies might well subscribe £400 by herself. If £5 is too heavy a tax for one indi-

vidual to undertake, there are surely five medical men in every one of our large towns each of whom would subscribe £1, and so form a group which would receive a copy of the Index for their common use; while institutions and societies should have no hesitation in voting the required amount. Those who are willing to subscribe are requested to communicate with the Librarian, Royal Medical and Chirurgical Society, 20 Hanover Square, London, W."

At a recent meeting of the Michigan State Board of Health, the means of carrying out a new act of the Legislature passed at the instance of the board were discussed. This act requires the State Board of Health annually to send to public school superintendents and teachers throughout the State, printed data and statements which will enable teachers to teach their pupils the modes by which the dangerous communicable diseases are spread, and the best methods for the restriction and prevention of such diseases. This same law provides a fine or forfeiture in cases where any school board wilfully neglects to comply, and such neglect by any superintendent or teacher is sufficient cause for dismissal. There are 16,000 teachers in the State who will be required to spread sanitary information to their pupils. From a better and more general knowledge of diphtheria alone it is hoped that there will be a saving of life and money values equal to an amount much greater than the State now expends for the maintenance of the State Board of Health.

THE International Congress of Otology, held at Florence on September 23rd, will be attended by the leading aural surgeons of Europe and America. The last congress was held in Brussels in 1888.

PROFESSOR J. MARK BALDWIN, of Princeton, is coöperating in the preparation of the new French *Dictionnaire de Physiologie*, of which Professor Ch. Richet is the general

editor. Among the more important topics assigned to Professor Baldwin are *Intelligence* and *Heredity*.

THE question whether a child is naturally moral or immoral will be taken up by Professor James Sully in *The Popular Science Monthly* for September. This article will be devoted to primitive egoism and altruism, and will show that many of a child's acts that seem perverse or cruel are explained when we try to look at things from the child's personal standpoint.

THE first number of the American Journal of Sociology has been issued from the press of the University of Chicago under the editorship of Professor Albion W. Small. The number opens with an editorial article entitled 'The Era of Sociology,' followed by an article on 'The Place of Sociology Among the Sciences' by Lester F. Ward. The other articles are contributed by members of the University of Chicago.

SIR JOHN TOMES, a distinguished dental surgeon and writer on dental anatomy, died at Caterham, England, on July 29th. He was born at Weston-on-Avon in 1815. In addition to a large number of scientific papers he published in 1848 a 'Dental Physiology and Surgery' and in 1859 'A System of Dental Surgery.' In its latest edition the latter work is regarded in England as the standard text-book on the subject.

JOSEPH DERENBOURG, professor of oriental languages at the École Pratique, died at Paris on August 5th in his 84th year.

DR. GEORGE STEVENS, professor of English language and literature in the University of Copenhagen, died in Copenhagen on August 9th at the age of 82 years. He is known for his writings on history, folklore, linguistics and runology.

DR. VON GNEIST, professor of jurisprudence in the University of Berlin, died on July 21st, at the age of 79.

CORRESPONDENCE.

CAUSES OF THE GULF STREAM.

I AM convinced that one of the most important functions of such a journal as SCIENCE is the friendly criticism of articles whether appearing in its own pages or in those of other journals. Much harm is done by allowing to go unchallenged even slight inaccuracies in scientific statements. Permit me then to draw attention to some such inaccuracies in our issue of July 26th.

1. In Mr. R. Meade Bache's excellent article on the 'Causes of the Gulf Stream,' which I have read with the greatest interest and satisfaction, on page 89, 2d column, in speaking of these causes the writer says: "One of these, the centrifugal force of the earth's rotation, *draws the water as a submarine flow* from the poles to the equator." And again on page 92 he criticises Carpenter for omitting 'this agency of rotation.' Now, to say the least, this is an inaccurate mode of statement. For on the equilibrium theory, which he is sustaining, the only force which determines the exchange between poles and equator is difference of density. Rotation cannot *generate*, but only *deflect* a current already generated by some other cause. Centrifugal force determines the form of equilibrium, but does not disturb the equilibrium, and therefore cannot generate a current.

2. Again, on pp. 92 and 93, he says: "Both the Northern connecting current and the Southern connecting current run for the greater portion of their course *due east*, and therefore the direction of their courses is not, for that portion of their journey, influenced (deflected) by the rotation of the earth." Here we have again the very common but wholly false idea that deflection by rotation takes place only in bodies moving northward or southward. The fact is, the deflection is a function of latitude, but wholly *independent of the direction of motion*.

A current or a projectile or a Foucault pendulum is equally deflected whatever be the direction of motion. The deflection is always to the right in the northern hemisphere and to the left in the southern. An eastward going current in both hemispheres is deflected toward the equator.

THE NATURE OF VOWELS.

MY next criticism is of a statement contained in article taken from the *London Times*. This, of course, is not an authoritative source, but since it reappears in SCIENCE it ought not to go unchallenged.

Speaking of the use of the phonograph in analyzing complex sounds, the writer says: "Hermann has obtained the curves corresponding to the tones of the vowels and has shown that vowels are true musical tones, *each having its own pitch*, and not, as Helmholtz supposes, the pitch of a harmonic tone corresponding to the shape of the oral cavity."

Now it is true that the vowels are true musical tones, but it is not true that each has its own pitch. The vowel sounds are a phenomenon, not of pitch, but of quality or *timbre*. All the vowels can easily be made successively without at all altering the pitch of the voice. Pitch is made in the larynx; the timbre is made in the mouth cavity. The one depends on the *number*, the other on the *form* of the waves. Doubtless the phonograph will prove a very useful instrument in analyzing vowel sounds; doubtless the investigations of Hermann and others mentioned are important; doubtless Helmholtz's theory will be corrected and improved, but that the vowel sounds are a phenomenon of timbre and not of pitch is too plain to be doubted. The writer has not fully understood or else not clearly stated either Helmholtz's theory or the bearing on it of these recent investigations.

JOSEPH LE CONTE.

UNIVERSITY OF CALIFORNIA.

[It would add much to the interest and value of this journal, and thus contribute to the advancement of science, if we should all follow the recommendations made by Professor Le Conte in his opening paragraph. J. McK. C.]

SCIENTIFIC LITERATURE.

Analytical Chemistry. By M. MENSCHUTKIN; translated by JAMES LOCKE. Macmillan & Co. Pp. 512. \$4.00 net.

Among the numberless text-books on analytical chemistry, the well-known work of Menschutkin appears to occupy a unique position in this respect, that the author emphasizes the didactic rather than the practical value of this branch of chemistry. Skill and accuracy in Qualitative and Quantitative Analysis have such a distinct commercial value that we cannot properly find fault with the share of attention they receive in the chemical curriculum of most institutions; the supply of competent analysts and essayers cannot be too great. But, in this age of specialization, it is allowable to ask whether the elementary education of the scientific investigator ought to be identical with that of the analyst.

Largely through the influence of one great writer, analysis has been 'codified,' and 'Fresenius' has become for the chemical student what 'Blackstone' is to the beginner in law. The ease with which we can acquire the principles and methods of analysis, by the careful study and practice of such a code, is wonderful; but we do not, in the meantime, advance appreciably beyond that point, in *chemical knowledge*, where the Elementary Inorganic Chemistry had left us. Menschutkin's book is intended, according to its Introduction, for students who propose advancing into Organic, Physical and Theoretical Chemistry, and he strives to cultivate the same habits of thought, in their study of Qualitative Analysis, as will be essential in the advanced branches.

This is an admirable standpoint, and one which should ensure the book a reading from all earnest students.

Unfortunately, there are a number of defects that impair its usefulness as a textbook. In the effort to enhance its didactic value by adhering to the inductive method, systematic treatment has been neglected. Descriptions of apparatus, operations and manipulations are introduced in such sequence as may afford the student progressive practice, indeed, but in no strictly logical order. As there is a very scanty index, it is impossible to refer to particular operations, for instance, without reading the book through. Unnecessary verbiage, frequent repetitions of facts already stated, facts connected very remotely with the subject in hand, tend to break the continuity and unnecessarily to increase the bulk of the volume.

Several times the wrong equations are given intentionally, 'because the right ones would be too complicated.' This seems to be rather unscientific treatment.

As for the actual subject-matter, both the special reaction and the systematic methods of Qualitative Analysis appear to be admirably chosen. Is it not time, however, that schemes for complete analysis should consider the possible presence of elements so frequently met with in natural and artificial products as are titanium, lithium, uranium and tungsten? It is also peculiar that, while the rarer elements are dismissed in the Qualitative Analysis, with a few paragraphs describing their most characteristic special reactions, these same paragraphs contain detailed instructions for their purification and quantitative determination!

The quantitative analysis of the common elements is treated in the last two hundred pages in an admirable manner, the separations especially receiving adequate consideration. But it seems queer to read of certain methods as recently discovered,

which have been in use ten or fifteen years; while the author appears to be quite unfamiliar, for instance, with the Gooch Crucible, whose use has removed so many obstacles from the analyst's path.

The translation is not done very skillfully—it is unidiomatic, and in many passages two or three readings are required before the author's sense can be accurately ascertained.

MORRIS LOEB.

UNIVERSITY OF THE CITY OF NEW YORK.

A Treatise on Civil Engineering. By W. M. PATTON. New York, John Wiley & Sons. 1895. Octavo, pp. xviii, 1654. Price, \$7.50.

Fifty years ago it was easy to compress the science and art of civil engineering into a single volume; to-day it is an impossibility. Civil, as distinguished from military, engineering is scarcely a century old, but its growth has been so vigorous, and the branches of its activity are so numerous, that the term is becoming somewhat vague. Telford's definition—the art that utilizes the materials and forces of nature for the benefit of man—was a good one in 1818, but it now can only be applied to the whole field of construction which is now subdivided into civil, mechanical, mining and electrical engineering.

The best definition that can now be given is perhaps the following: Civil engineering is the science and art of economic construction undertaken for the purpose of facilitating the transportation of men and matter. It thus embraces roads, railroads and canals, upon which men and freight are transported, together with river and harbor improvements; irrigation, water and sewerage systems for the transportation of water and sewage; and all the necessary foundations, bridges and structures for these objects. It includes all the surveys, estimates and mechanical principles required to build and maintain such construction in the most

economic manner consistent with the proper degree of security. The wonderful progress of the nineteenth century has, however, caused civil engineering to become divided in practice into special departments like railroad engineering, bridge engineering, irrigation engineering and sanitary engineering.

Mr. Patton's treatise, when tested by the above definition, is found to be defective; at the same time it is better and more comprehensive than would be expected when the vast range of the subject is considered. It includes fifty-nine chapters, together with an appendix of 125 pages. Many chapters contain information that can be found in no other single volume, clearly presented, well illustrated, and often set forth with the weight of authority that can attach only to the writings of an engineer who has long been in responsible charge of important construction work. Other chapters are compiled from standard treatises on special subjects, or from periodical literature. Throughout care and thoroughness are apparent, and a volume has been produced which is likely to be of much value to the younger members of the engineering profession.

Strictly speaking, the book is not a treatise, but its character is cyclopædic. A treatise is a classified and logical presentation in which causes precede their effects. Above all works on civil engineering, Rankine's manual stands highest as a treatise, for its theory is set forth in most logical relation to practice. Rankine's theory, though often difficult for students, is his own, and carefully coördinated on a uniform plan. Mr. Patton's method is one more suitable for a cyclopædia than a treatise, as his theoretic discussions have been largely adopted from other authors and have little coördination. For instance, the theory of earth pressure is taken from one author, the theory of trusses from another, and the theory of elas-

tic arches from a third. This has not been done without due credit, but in a treatise all these should have been worked out on a uniform basis and with systematic classification. Some investigations are also left more or less incomplete, with references to books where thorough discussions may be found. Such methods detract from the logical completeness that a true treatise should possess.

In one respect Mr. Patton has improved on the method of Rankine. Numerical examples are given illustrating the application of the theory. This is absolutely necessary for students and for most engineers, as algebra is always hazy, and mechanical principles are rarely well understood until they are applied to concrete problems. These examples are well selected to illustrate engineering practice, and they are usually worked out in a complete manner.

The most valuable and authoritative chapters are those relating to construction work, including earthwork, masonry, foundations, arches, dams, tunnels and river and harbor improvements. Numerous detailed descriptions of important works are presented to illustrate the best modern practice. The subject of the materials of engineering is set forth, not exhaustively, but clearly and well. As a cyclopædia of construction work the book may properly be called one of high rank.

The theory of bridges occupies much space, but it does not appear that the discussions contain any material improvements over the authorities whose methods have been mainly followed, unless it be in numerical illustrations. On hydraulic and sanitary engineering the book is weak. A few hydraulic formulas of value are given, but several long since discarded are also stated, and the elaborate determinations of hydraulic coefficients made in recent years are quite unnoticed. The separate system of sewerage is not mentioned, and little is

given relating to water works. These omissions show the defects of the author's system of classification, and demonstrate how impossible it is to write a satisfactory one-volume treatise on civil engineering at the present day. A comprehensive treatise, like the *Handbuch der Ingenieurwissenschaften*, must consist of many volumes and be the work of many men.

MANSFIELD MERRIMAN.

LEHIGH UNIVERSITY, July 29, 1895.

Electricity Up to Date for Light, Power and Traction. JOHN B. VERITY. London and New York, Frederick Warne & Co. 1894.

The preface of this book tells us that 15,000 copies have found their way into circulation. The title is a misnomer, unless the date is mentioned. In these days of active investigation and rapid application of discovered principles a book on electricity is out of date as it drops from the press. This statement is exemplified in this publication. The recent lucid investigations of Mr. R. E. Crompton on electric heating do not appear, and the surprising results of Mrs. Ayrton on the electric arc receive no mention. The various prime movers are mentioned, excepting the steam turbine, which, perhaps, is the most promising of all motors. The author ignores pretty generally what America is doing in the electric field, except in the case of Edison, to whom he gives credit for what was known before Edison was born—'the subdivision of the electric light.'

One of the first and certainly one of the simplest arc lamps, and the one most used, the Brush, receives no mention. There are several expressions which ought to be omitted from popular books, to prevent the spreading of erroneous ideas. Among these are 'Storage of Electricity,' used in this book as the head of a chapter; 'Electric Pressure,' for 'Difference of Potential.'

The confounding of these terms causes great confusion in the schools. We expect better things in a book which professes to be both scientific and popular. On page 184 is the statement that in a wire through which a current of electricity is passing 'the heat generated is proportional to the quantity of current used;' it would have been just as easy to have stated the exact law. The book is well printed and illustrated, but it is difficult to treat so large a subject in 200 pages with success.

J. W. MOORE.

LAFAYETTE COLLEGE.

Neudrucke von Schriften und Karten über Meteorologie und Erdmagnetismus herausgegeben von Professor Dr. G. Hellmann, No. 4. E. HALLEY, W. WHISTON, J. C. WILCKE, A. VON HUMBOLDT, C. HANSTEEN. *Die ältesten Karten der Isogonen, Isoklinen, Isodynamen; 1701, 1721, 1763, 1804, 1825, 1826.* Berlin, A. Ascher & Co. 1895. Sieben Karten in Lichtdruck mit einer Einleitung. 26 pp., 4to.

The above forms No. 4 of the very interesting series of reprints in facsimile of epoch-making rare old books or charts in Meteorology and Terrestrial Magnetism edited by the well-known meteorologist and bibliographer, Professor Hellmann, of Berlin.

Like its predecessors,* the number before us commends itself by its keen, critical and thorough research, by its beautiful typographical execution and by the lowness of the price. Hardly one of the seven charts given could be obtained for the price (5 marks) asked for the whole. It is needless to remark that the editor of these successful reprints and his coöperators, the German Meteorological Society and its Berlin Branch, have thus merited the warmest

* No. 1. L. Reynman: *Wetterbüchlein. Von wahrer Erkenntniss des Wetters.* 1510.

No. 2. Blaise Pascal: *Récit de la Grande Expérience de l'Equilibre des Liqueurs.* Paris, 1648.

No. 3. Luke Howard: *On the modifications of clouds.* London, 1803.

praise. The pure geomagnetician will find additional satisfaction in the fact that Professor Hellmann appears to have abandoned his original intention of publishing the earliest meteorological and magnetic charts in one and the same volume. This differentiation of purely meteorological and magnetic matter cannot be too highly commended.

As announced in the title, the purpose of this number is to reproduce in facsimile the earliest geomagnetic charts. The amount of careful and painstaking research, as evinced by the many copious notes following the text, necessary for the completion of this task can only be thoroughly appreciated by those who have made similar attempts.

Plate I, gives Halley's famous lines of equal variation or magnetic declination for the epoch 1700.

Plate II, the earliest (1721) lines of equal magnetic inclination by W. Whiston for southern England and the Channel.

Plate III, the earliest *general* chart of the lines of equal inclination by J. C. Wilcke, published in 1768.

Plate IV, Humboldt's attempt at a representation of the distribution of the intensity of the earth's magnetism on both sides of the equator passing through Peru.

Plate V, the earliest delineation of the lines of equal magnetic force by Hansteen, published in 1825 and 1826.

A limited number of copies of the above can be obtained from the reviewer at the price named.

L. A. BAUER.

UNIVERSITY OF CHICAGO.

SCIENTIFIC JOURNALS.

THE PHYSICAL REVIEW, VOL. III., NO. 1,

JULY-AUGUST.

Thermal Conductivity of Copper. By R. W. QUICK, C. D. CHILD and B. S. LANPHEAR.

In a former paper (Phys. Rev., Vol. II., No. 6) the writers have given an account

of experiments made to determine the conductivity of copper at temperatures ranging from 70° to 170°. The present article is devoted to experiments upon the same copper bar at temperatures below 0°, the results being, so far as the writer is aware, the first that have been obtained for this range of temperatures. Several modifications in the method employed were made necessary by the new conditions. As a cooling bath, in which one end of the test bar was immersed, a mixture of solid CO₂ and ether was used. The temperature obtained by this means was about -70°. The formation of frost on the surface of the cold bar was a source of some annoyance, but was finally prevented by placing the bar in a large box filled with dry air. The temperature of the bar was measured, as in the previous experiments, by the resistance of a coil of fine copper wire, whose temperature coefficient was determined by reference to the melting points of ice and mercury.

The results show a variation in conductivity from 0.921 at -54° to 1.059 at 13°. It is to be observed that the increase of conductivity with rise of temperature corresponds with the behavior of the bar at high temperatures. The increase is, however, more rapid for temperatures below 0°. On the other hand, the average value of the conductivity for the range -54° to -13° is found to be slightly greater than the average value between 70° and 170°. Either, therefore, the results have been affected by some undiscovered source of error, or else the curve of conductivity must possess a maximum at some temperature between -14° and +70°. Determinations of conductivity for temperatures lying between this range are to be desired.

On Ternary Mixtures. I. By W. D. BANCROFT.

The attention which in recent years has been devoted to the subject of dissociation,

and to the development of the analogy between a dissolved substance and a gas, has heretofore prevented a systematic consideration of the more complex cases in which the solubility of one substance is influenced by the presence of a second. In the paper before us, which is the first of a series of articles on Ternary Mixtures, the experimental investigation of one of the simplest of such cases is begun: viz., the case of three liquids, two of which are non-miscible, while the third is miscible with each of the others in all proportions. Experiments were made with chloroform and water, and benzol and water, as non-miscible liquids, while ethylalcohol, methylalcohol and acetone were used as solvents. The quantity of solvent being kept constant, the amounts of the other two components necessary to produce saturation were determined. The results are found to be closely in agreement with the 'mass law': i. e., if x and y denote the amounts of the non-miscible liquids the condition for saturation is $x^a y^\beta = C$ where a , β , and C are constants. When the curve showing the relation between x and y is plotted it is in general found, however, that a single curve is not sufficient to represent the experimental results. There appear to be two sets of conditions leading to equilibrium. A mixture of chloroform, water and alcohol may, for example, be saturated with respect to chloroform; in which case a precipitate of the latter liquid will be formed on the addition of either chloroform or water. A mixture of the same liquids may also be made which is saturated with respect to water. The proportions of water and chloroform are, of course, different in the two cases. The paper contains a discussion of several such cases, as well as numerous tables of experimental data.

On the Secular Motion of a Free Magnetic Needle. II. By L. A. BAUER.

The accumulation and discussion of the observational data used by Dr. Bauer have been described in the first half of this paper (Phys. Rev., Vol. II., No. 6), and have already been noticed in SCIENCE. Practically all available sources of such data have been thoroughly searched, and the results collected constitute in themselves a valuable contribution to the literature of geomagnetism. By a combination and comparison of these data the author derives in the present paper certain important general laws regarding secular magnetic changes, which can perhaps best be stated in the language of the paper:

1. "In consequence of the secular variation of geomagnetism, the north end of a freely suspended magnetic needle, viewed from the center of suspension of the needle, moves on the whole earth in the direction of the hands of a watch."
2. "The secular variation curves appear to develop themselves more and more as we go around the earth eastwardly; or, in other words, the secular wave appears to travel in the main, roughly speaking, westward."
3. "The north end of a free magnetic needle, viewed from the center of suspension of the needle, moves clockwise in making an instantaneous easterly circuit of the earth along a parallel of latitude."
4. "The secular variation and the prevailing distribution of geomagnetism appear to be closely related."

Plates showing secular curves at different stations, as well as 'instantaneous curves' for several latitudes, accompany the paper. The author promises a mathematical discussion of the subject in the near future. Apart from the interest and value of the results obtained by Dr. Bauer, the directness and thoroughly scientific character of the work done form a pleasant contrast to the speculative and superficial methods by which the complex problem of geomagnetism are so often attacked.

A Galvanometer for Photographing Alternating Current Curves. By H. J. HOTCHKISS and F. E. MILLIS.

For the investigation of many important

alternating current problems the determination of the wave form by the ordinary method of instantaneous contacts is subject to many disadvantages. This method gives at most only a mean wave curve, corresponding to *steady* conditions. Some continuously recording instrument has long been needed, especially in the case of problems dealing with sudden changes in the conditions. But although numerous forms of apparatus have been suggested and tried, none of the methods proposed appears to be entirely satisfactory. The apparatus described in this article was construed by Messrs. Hotchkiss and Millis for use in the study of sudden changes in an alternating current; such, for example, as the change brought about by a sudden change in load of a synchronous motor. The apparatus consists essentially of a very light needle, which is merely a mirror mounted on a piece of soft iron, suspended in a rather strong magnetic field. Surrounding the needle is a coil which carries the alternating current to be studied, the axis of the coil being perpendicular to the lines of force of the field. The needle is held in its zero position partly by the magnetic effect, and partly by the torsion of the short fiber, the latter being attached both above and below the needle. Being deflected by the action of the current it indicates current strength by its deflection, and constitutes a true galvanometer. A photographic registering device enables a continuous record of the variable current to be obtained.

The essential requirement for accuracy in such an instrument, viz., a short period of vibration, seems to have been filled. The frequency in the case of the five needles used varied from 2850 to 3950 complete vibrations per second. Curves taken from various types of alternating generation are shown, in which no trace of the natural vibration of the needle can be seen. Several 'make' and 'break' curves are shown also,

both for alternating and direct currents, which are of considerable interest.

The authors call attention to the fact that the apparatus can be used for other purposes besides the study of alternating currents. One interesting example of its application is a curve showing the temperature variation in the interior of a steam-engine cylinder during a single stroke, the temperature measurement depending on the change in the resistance of a fine iron wire.

Experiments with a New Polarizing Photo-Chronograph as Applied to the Measurement of the Velocity of Projectiles. By A. C. CREHORE and G. O. SQUIER.

To avoid the errors due to inertia, which are present in all ordinary types of chronograph, the present form of instrument is made to depend upon the rotation of the plane of polarization by a current. In the path of a beam of light, which is converged upon a moving photographic plate by a lens, are placed crossed nicols, and between them a tube filled with carbon bisulphide. If current flows in a coil surrounding this tube, light is restored, while if the current is broken, the light reaching the plate is *immediately* suppressed. The apparatus is especially suited to the measurement of small time intervals. In addition to a description of the instrument, the article contains an account of experiments made with it to determine the velocity of projectiles.

Experimental Demonstration of a Law of Fluid Pressure. W. J. HUMPHREY.

A description of a simple apparatus for showing that the pressure of a fluid is the same in all directions.

Books Reviewed.—Hertz. *Die Principien der Mechanik.* S. P. Thompson. *Elementary Lessons in Electricity and Magnetism.* Yeo. *Steam and the Marine Steam Engine.*

THE AMERICAN GEOLOGIST, AUGUST.

Joseph Granville Norwood, M. D., LL. D. By G. C. BROADHEAD.

Dr. Norwood's geological work was done between the years 1845 and 1855. He was associated with Dr. D. D. Owen in the Geological Survey of Wisconsin, Iowa and Minnesota, and was later State Geologist of Illinois. From 1860 to the time of his death (May 6, 1895) Dr. Norwood held a professorship in the University of Missouri, but on account of ill health his active work with that institution ceased in 1880. The paper is accompanied by a portrait and a list of publications.

The Keweenawan According to the Wisconsin Geologists. By N. H. WINCHELL.

This is the sixth in a series of papers entitled 'Crucial Points in the Geology of the Lake Superior Region.' With the conclusions of the Wisconsin Geological Survey concerning the Laurentian and Huronian the author does not essentially disagree, but he criticises the conclusions regarding the Keweenawan and the Upper Cambrian sandstones. It is stated that the Keweenawan was introduced by a period of subsidence and the deposition of conglomerates and sandstones, and that the great igneous activity of this age was later than these basal clastic rocks; the opposite view was held by the Wisconsin geologists. The author also brings forward evidence to show that there was not necessarily a long erosion interval (and a consequent unconformity) between the Keweenawan and the Upper Cambrian sandstones, as was held by the Wisconsin Geological Survey.

Superior Mississippian in Western Missouri and Arkansas. By CHARLES ROLLIN KEYES.

Recent work has shown that the upper Mississippian rocks in western Missouri, which have been regarded as not presenting a series easily parallelized with the typical rocks of this age in the Mississippi valley, are present in both their superior and inferior portions. The Burlington limestone is practically the same as at the typical

locality, and a typical Kaskaskia fauna is present in the uppermost member of the Mississippian.

Glacial Notes From the Planet Mars. By E. W. CLAYPOLE.

A summary of knowledge concerning the polar caps of Mars, which are believed to be composed of snow and ice, is presented. It is shown that Mars affords no evidence in support of the eccentricity theory of glacial cold, though his conditions are at present such as to favor a state of intense glaciation in his southern hemisphere.

Correlations of Stages of the Ice Age in North America and Europe. By WARREN UPHAM.

The series of stages of fluctuating growth and decline of the ice sheets on both sides of the North Atlantic are shown to be nearly alike and probably contemporaneous, so that the names proposed by Chamberlin for the principal American stages are applied also to the European, these names being here given on maps of the glacial drift of each continent. The marginal moraines of each are referred to the Champlain epoch, which was the short closing part of the Glacial period.

Besides the foregoing articles, this number contains departments of editorial comment, reviews of recent geological literature, lists of recent publications in geology, and personal and scientific news.

NEW BOOKS.

The Principles of Physics. ALFRED P. GAGE. Boston and London, Ginn & Co. 1895. Pp. ix + 634.

An Introduction to Chemical Crystallography. ANDREAS FOCK. Translated and edited by WILLIAM J. POPE. Oxford, The Clarendon Press. 1895.

Petrology for Students. ALFRED HARKER. Cambridge, University Press. 1895. Pp. viii + 306. \$2.00.